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(19)

(54) MANUFACTURE OF SHEET MATERIAL

(71) We, FELDMÜHLE ANLAGEN- UND PRODUKTIONS GESELLSCHAFT MIT BESCHRANKTER HAFTUNG, a Company organised according to the laws of Germany, of Fritz-Vomfelde-Platz No. 4, Dusseldorf-Oberkassel, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the manufacture of a sheet material having a high permeability to air and water vapour and a high capacity for absorbing water.

Many attempts have been made to solve the problem of providing porous, abrasion-resistant and break-resistant sheet materials that have a soft feel, a high absorbent capacity and good drying properties, for example, when used in drying table-ware and the like, and which also have a good resistance to washing. Many processes have been proposed for solving this problem.

For example, there are processes in which non-woven fibrous materials are subjected to (optionally multi-stage) impregnation with an aqueous dispersion or emulsion, for example in the form of foam or paste, of a film-forming vulcanizable adhesive agent, and there are uniformly incorporated in the material, by one or more impregnations, finely divided substances capable of being removed by dissolving them out. These substances act either as coagulating agents and pore-formers, for example, ammonium carbonate or sodium sulphate, or as pore-formers only, for example, urea or thiourea, and after the or each impregnation the material is suitably treated, preferably by heat treatment, to solidify the impregnating material introduced. After the final solidification the material is subjected to treatment with water or an aqueous solution to dissolve out the port-former or coagulating agent. See, for example, German Patent Nos. 910,960 and 1,182,425 and DAS 1,204,186.

German Offenlegungsschrift No. 1,807,579 describes a process for the manufacture of suède-like material, in which there is formed between two carrier layers, for example, webs of non-woven fibrous material, a polymer layer having relatively large spongy internal spaces, by the coagulation of a layer of polymer solution in a coagulating bath, and this material is then split in the middle of the polymer into two separate webs by pulling apart the two carrier materials.

The above-mentioned processes are complicated owing to the large number of process steps and are therefore costly, and do not result in satisfactory porous highly absorbent sheet materials.

The present invention provides a process in which there is applied to at least the inner faces of the webs of a non-woven fibrous material in a discontinuous form a coagulating agent for the synthetic plastics and then applying a foamed synthetic plastics material (in a form in which it is capable of penetrating the fibrous material, and) preferably in the form of a dispersion, between the webs of fibrous material and drying it, and the product resulting therefrom.

The spatially discontinuous application of the coagulating agent, which is normally in pulverulent form, in accordance with the process of the invention is of importance, on the one hand, to achieve sufficient anchoring of the layer of foam material in the two webs of fibrous material, and, on the other hand, to prevent deep penetration of the foam-like binding agent in a continuous form, which would inevitably cause collapse of the foam and closed film formation within the webs of fibrous material.

The application of the coagulating agent in

a discontinuous form is preferably effected by dusting-on a solid coagulating agent, advantageously by means of a vibrating sieve, so that at some parts of the surface of the fibrous material the synthetic plastics foam is prevented by coagulation from penetrating into the web of fibrous material and, at neighbouring places, where there are no particles of coagulating agent the synthetic plastics foam can penetrate into the web of fibrous material and there become solid and well anchored.

In another advantageous form of the process of the invention the coagulating agent is applied in liquid form as spots to the webs of fibrous material, which can be effected in a simple manner by a suitably constructed applying device, for example, by means of a roller having a coarse screen. A preferred method of effecting application in a discontinuous form is to apply the coagulating agent by spraying. By suitably arranging and selecting the spraying member it is not difficult to achieve a substantially spot-like application of the coagulating agent.

An especially advantageous way of carrying out this aspect of the process is to apply the coagulating agent and dry it before applying the synthetic plastics foam. The said agent then develops its coagulating action when the foam material is applied preferably in the form of a dispersion. The advantages of this method are that the coagulating agent can be applied separately, both spatially and in time, and that it is possible to avoid any undesired action on the dispersion of the foam material, such as can easily happen when the coagulating agent is simultaneously applied by spraying.

As coagulating agents there are advantageously used water-soluble compounds such as alum, sodium sulphate and similar electrolytes.

The permeability to air and water vapour can be increased in a manner in itself known by using coagulating agents which, during drying, also act as blowing agents and thus produce pores in the layer of synthetic plastics foam, for example ammonium carbonate, or by using blowing agents in addition to coagulating agents.

Depending on the properties desired in the final product, the finished sheet material may be subjected to after-treatments, for example, roughening. A preferred method of producing a finished product having one surface that is smoother and has more nap is to split the sheet material into two webs, so that one surface of each web is the outer surface of a web of fibrous material and the other surface thereof is formed by the synthetic plastics foam. The present invention accordingly provides such a product.

For some uses it is desirable still further to improve the properties of the sheet materials especially by rendering the outer surfaces resistant to abrasion, so as to reduce their tendency to pill formation and to give them a better feel towards smooth surfaces, such as window panes. It is, however, important that the high porosity and the permeability to air and water vapour associated therewith not be impaired.

Accordingly in an especially advantageous further form of the process of the invention synthetic plastics in the form of a foamed dispersion is applied to the outer faces of the webs of fibrous material, a coagulating agent is subsequently applied, and the outer coating is dried.

By applying a foamed synthetic plastics dispersion to the outer faces of the webs of fibrous material the fibres thereon are firmly bound and cannot become loose after long use. The succeeding, and preferably also discontinuous, application of a coagulating agent has a dual effect. First, formation of a continuous film is avoided, and, second, in the final step of the treatment of the whole sheet material, namely the dissolving out of the coagulating agent at the places where the coagulating agent has acted, porosity is produced and thus the good permeability to air and water vapour of the whole sheet material is maintained. The prevention of formation of a continuous film is important also because it causes a certain profiling of the surface, which is of vital importance for the desired feel of the sheet material, especially towards glass and other smooth materials.

The application of the foamed synthetic plastics dispersion to the outer surfaces of the webs of fibrous material can be carried out on the finished sheet material, that is to say, after introducing the foamed dispersion between the webs and then drying. Preferably, however, the coating of the outer faces is carried out before uniting the two webs of fibrous material and before the introduction of the synthetic plastics intermediate layer. This procedure has advantages, especially also with respect to the drying technique, because no liquid can be forced from the outer coating into the intermediate layer.

As foamable synthetic plastics dispersions for the outer layer there are used in practice the same synthetic plastics as are used for the intermediate layer. The same applies to the coagulating agents, among which sodium sulphate is preferably also in this case.

The quantity of the coagulating agent for the outer layer depends to a certain extent on the synthetic plastics dispersion and the thickness of the coating. With the usual coating weights of the order of 15 to 30 grams per outer layer 10 to 50 grams of sodium sulphate per square metre are sufficient, and within these relatively wide limits the permeability to air attained with increasing quantities of applied sodium sulphate also increases. With

quantities greater than 50 grams the increase in permeability obtainable is small, so that the use of sodium sulphate in quantities greater than this is not profitable and other properties of the sheet material are adversely affected.

The present invention also provides apparatus that is especially suitable for carrying out the process of the invention, and such as is more fully described with reference to the drawings, the apparatus comprising two foam-applying rollers enclosing a gap, means for supplying the foamed material to the gap, having arranged on both sides thereof devices for applying the coagulating agent so that webs have the coagulating agent applied thereto before reaching the gap. These devices are advantageously vibrating sieves when a solid pulverulent coagulating agent is used or spraying nozzles when the coagulating agent is used in liquid form. After the said rollers there is arranged a pair of withdrawing rollers, which are advantageously profiled if the finished product is to have, for example, a grained surface. Advantageously, the distance between the rollers of each pair of rollers is adjustable so that the thickness of the layer of synthetic plastics foam can be influenced both during coating and after solidification has commenced. The rollers are advantageously provided with a drive such that excessive pulling forces need not be exerted by the roller on which the finished product is finally wound after the drying zone.

In an especially advantageous construction of the withdrawing rollers, one of these rollers over the greater part but not the whole of its length has a diameter smaller than that of the other roller. This is achieved by narrow shoulders in the region of each end. This has the advantage that the thickness of the sheet material is determined primarily by the height of the shoulders and not by the pressure of the rollers, owing to which a part of the porosity obtained would be lost. With this construction the thickness and porosity can be influenced to a certain extent by making the shoulders of compressible rubber. It is also possible to produce sheet materials of different thicknesses by the use of interchangeable rollers having recessed portions of different depths of interchangeable shoulders hav- different heights.

A preferred apparatus for carrying out the process of the invention is described below by way of example with reference to the accompanying diagrammatic drawings, in which

Fig. 1 is an isometric view of the apparatus and

Fig. 2 is an end view, partly in section, of the withdrawal rollers.

Referring now to Fig. 1, pre-strengthened webs 21 and 22 of non-woven fibrous material are fed from two feed rolls 1 and 2 under guide rollers 3 and 4 to a gap 23 formed by two rollers 5 and 6. "Pre-strengthened" as used herein means that the webs contain binding fibres, e.g., of cellulose coated plastics materials. By using vibrating sieves 13 and 14, which are connected to vibrators 15 and 16, a finely pulverulent coagulating agent, which may be mixed with a blowing agent, is applied in a discontinuous form to pre-strengthened webs 21 and 22 of material as they pass between the guide rollers 3 and 4 and the rollers 5 and 6. After delivery of foam from a foam container 18, on to the surfaces of the webs as they approach the rollers 5 and 6, the webs are drawn through the rollers 5 and 6, which compress the webs sufficiently to apply the foam over the whole surface of the web, the pre-strengthened webs 21 and 22 are drawn through rollers 7 and 8, after which the resulting united sheet material 20 is dried under suitable conditions. A foam container 18 serves to supply the gap between the foam-apply rollers 5 and 6 continuously with synthetic plastics foam prepared in the form of a dispersion and is connected by a flexible pipe 17 to a foam-production unit (not shown), a flexible pipe 19 serving as overflow for excess foam. For metering the supply of finely pulverulent coagulating or blowing agent to the vibrating sieves 13 and 14 there are supply hoppers 9 and 10, which communicate at their lower ends with rotatable rollers 11 and 12, of which the rate of revolution can be regulated, the space between the supply hoppers 9 and 10 and the rotatable rollers 11 and 12 also being adjustable and thus enabling the amount of powder delivered to be metered as desired.

Referring now to Fig. 2, there is shown an especially advantageous construction of the rollers 7 and 8, in which the roller 8 has a smaller diameter for the greater part of its length and has narrow shoulders in region of its ends.

The following Examples illustrate the manufacture of sheet materials in accordance with the invention:

EXAMPLE 1

There is used as starting material a pre-strengthened non-woven fibrous material having a weight of about 56 grams per square metre. By means of an apparatus as shown in Fig. 1 there is first applied to the two dry pre-strengthened webs 21 and 22 of fibrous material, which come from the rolls 1 and 2, during their passage between the guide rollers 3 and 4 and the foam-applying rollers 5 and 6, finely pulverulent sodium sulphate in a non-homogeneous manner at the rate of 46 grams per square metre by means of the vibrating sieves 13 and 14.

When the two powdered webs have passed between the foam-applying rollers 5 and 6, which are spaced 1.7 millimetres apart, there is continuously applied to the funnel-shaped

gap formed between the webs a dispersion of a synthetic plastics foam based on acrylic resin, which contains the usual foaming and thickening agents.

The treated webs are withdrawn by the rollers 7 and 8, one of which rollers, as shown in Fig. 2, has over the greater part of its length a smaller diameter than the other and has narrow shoulders in the region of its ends.

The product so obtained is dried at 120°C under conditions such that no migration of binding agent occurs, and is then heated at 150°C, whereupon cross-linking takes place.

In order to remove the sodium sulphate, the united web is subjected to a washing operation and is subsequently squeezed and dried.

There is obtained a highly absorbent product permeable to air and having the following properties:

Area weight	388 grams per square metre
Thickness	2 millimetres
Water absorption	4.6 grams per 50 square cm.
Water retention	0.5 gram per 50 square cm.
Absorbent power	4.1 grams per 50 square cm.

The material so obtained is useful for many purposes as a substitute for leather, and can be used, *inter alia*, as a window leather, or as a drying cloth for glasses or the like. Owing to its high absorbent power it is very suitable as a substratum in the manufacture of artificial leather.

Example 2

This Example illustrates the additional coating of the outer faces of the sheet material.

To a pre-strengthened non-woven fibrous material fleece having a weight of 49.6 grams per square metre there is continuously applied by means of a doctor a dispersion of a synthetic plastics foam based on acrylic resin, which contains the usual foam binding agents and thickening agents, and immediately thereafter there is applied finely pulverulent sodium sulphate in a non-homogeneous form by means of a vibrating sieve.

The fibrous fleece so coated is then dried at 120°C, and the binding agent is then fixed for a short time at 150°C.

The permeability to air according to Schopper of a fibrous material so treated will be seen from the following Table:

Quantity of Na_2SO_4	Permeability to air
0	21.1 litres per minute
12 grams per square metre	38.8 " " "
24 " " " "	46.4 " " "
36 " " " "	49.6 " " "
48 " " " "	54.4 " " "

The fibrous materials provided in the above manner with outer coatings and permeable to air and water vapour are then further worked up in the manner previously described into the final sheet material having between the fleeces a layer of synthetic plastics containing cavities.

The fibrous materials used in the present invention may, for example, be made of natural cellulosic materials or may be made from synthetic fibrous materials such as modified celluloses including cellulose ethers and cellulose esters, as well as polyamides and polyesters.

The foamed plastics material may be made for example, from latices of natural and synthetic rubbers, e.g. butadiene/styrene copolymers and butadiene/acrylonitrile copolymers, as well as polyurethanes.

WHAT WE CLAIM IS:—

1. A process for the manufacture of a sheet material having a high permeability to water vapour and air and a high water absorbence, comprising a pair of non-woven fibrous sheets joined by a foamed plastics layer, wherein there is applied in a discontinuous form to the surfaces of each of the sheets which are to face the layer a coagulating agent for the foamed plastics, and subsequently applying foamed plastics material, in a form in which it is capable of penetrating the fibrous sheet material, between the fibrous sheets to form the sheet material.

2. A process as claimed in claim 1, wherein the coagulating agent is applied by dusting on a solid coagulating agent.

3. A process as claimed in claim 1, wherein the coagulating agent is applied in a liquid state.

4. A process as claimed in claim 1 or claim 3, wherein there are used fibrous sheets to which the coagulating agent has been previously applied in liquid form and has been dried.

5. A process as claimed in any one of claims 1 to 4, wherein water-soluble compounds are used as coagulating agents.

6. A process as claimed in in any one of claims 1 to 5, wherein there is used as coagulating agent, or in addition to the coagulating agent, a substance that acts as a blowing agent during the drying.

7. A process as claimed in any one of claims

1 to 6, wherein the foamed plastics material is applied in the form of a dispersion and the material is subsequently dried.

8. A process as claimed in any one of claims 1 to 7, wherein after interposing the foamed plastics material, the sheet material is split approximately in the middle into two webs.

9. A process as claimed in any one of claims 1 to 8, wherein there is also applied to the outer faces of the sheet a synthetic plastic material in the form of a foamed dispersion, and subsequently a coagulating agent is applied in a discontinuous form and the outer coatings are dried.

10. A process as claimed in claim 9, wherein the coating of the outer faces is carried out before the two webs are united and the intermediate layer is applied by applying the coatings to the outer sides of the separate webs.

11. A process as claimed in claim 1, conducted substantially as described with reference to and as illustrated in Fig. 1 or Figs. 1 and 2, of the accompanying drawings.

12. A process as claimed in claim 1, conducted substantially as described in Example 1.

13. A process as claimed in claim 1, conducted substantially as described in Example 2.

14. Apparatus for carrying out the process claimed in claim 1, having two foam-applying rollers enclosing a gap, means for supplying the foamed material to the gap, vibrating sieves situated one on each side of the foam-applying rollers for supplying the coagulating agent and optionally the blowing agent, to a web upstream of the gap, and a subsequent pair of rollers for withdrawing the sheet material through the gap between the foam-applying rollers.

15. Apparatus as claimed in claim 14, characterised in that the distances between the foam-applying rollers and between the subsequent pair of rollers are adjustable.

16. Apparatus as claimed in any one of claims 14 to 15, characterised in that at least one of the subsequent pair of rollers is profiled.

17. Apparatus as claimed in claim 16, characterised in that one of the rollers has a diameter over most, but not all, of its length smaller than that of the other roller.

18. Apparatus as claimed in claim 14, substantially as described with reference to and as illustrated in Fig. 1, or Figs. 1 and 2, of the accompanying drawings.

19. An air and water vapour-permeable laminate comprising two laminae of non-woven fibrous material between which is a lamina of a foamed plastics material which is bonded to the fibrous material by impregnation of the fibrous material by the plastics material in parts, but not all, of their contacting surfaces.

20. An air and water vapour-permeable laminate comprising a non-woven fibrous material lamina bonded to a lamina of a foamed plastics material, the bond being formed by impregnation of the fibrous material by the plastics material in parts, but not all, of their contacting surfaces.

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1365734 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

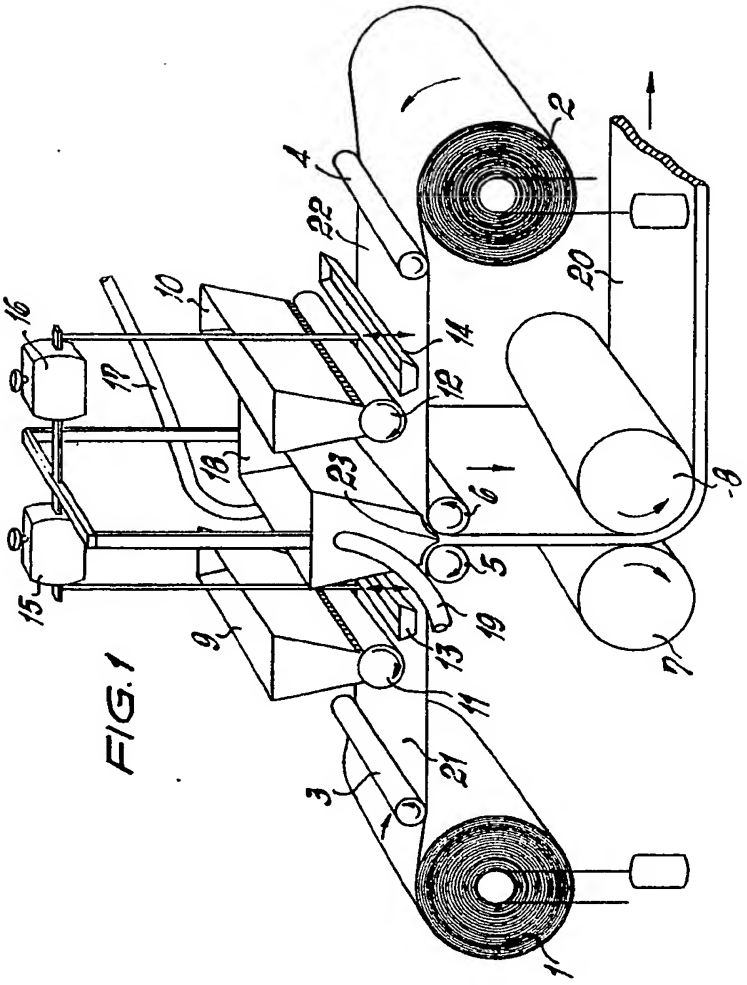

FIG. 1

1365734 COMPLETE SPECIFICATION
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 2

FIG. 2